ATF2 Interaction Point Beam Size Monitor (Shintake Monitor) Status

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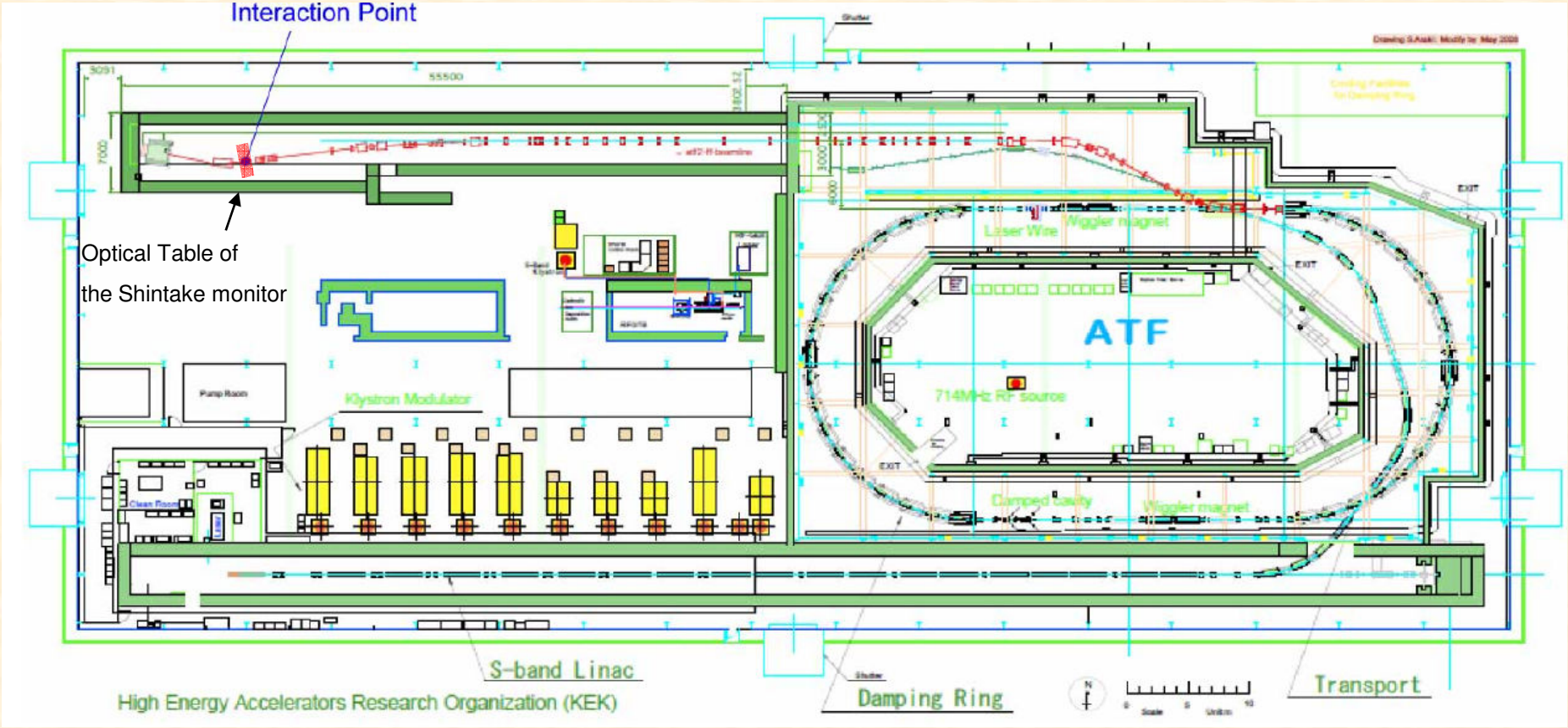
ATF/ATF2

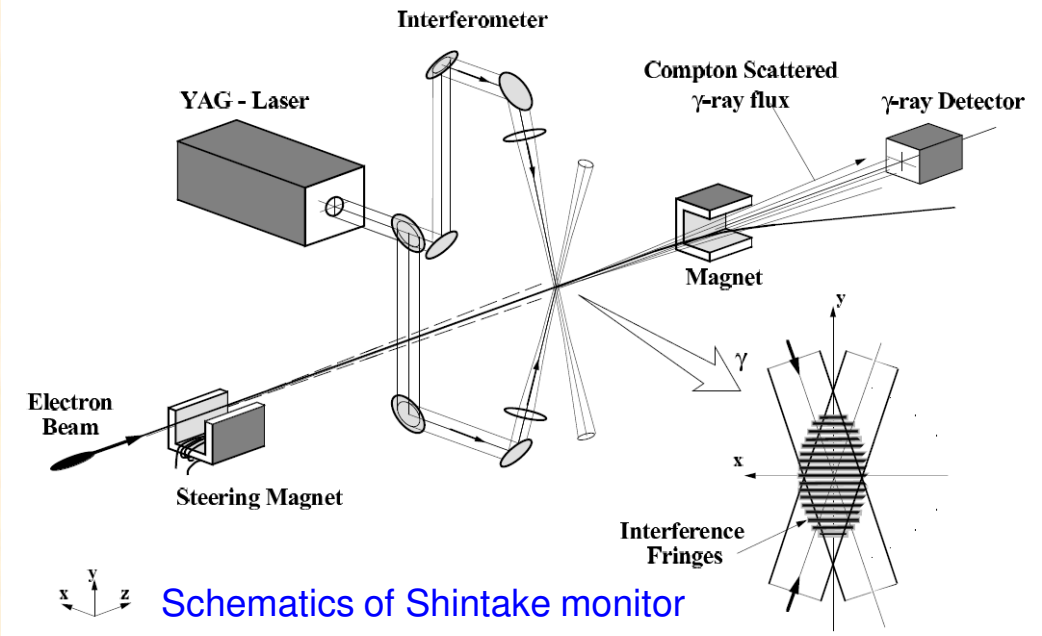


ATF/ATF2 Layout

ATF2 Goals

- Focus the electron beam to 35 nm in vertical
- Stabilize the vertical beam position with 2 nm resolution

Principle of Shintake Monitor

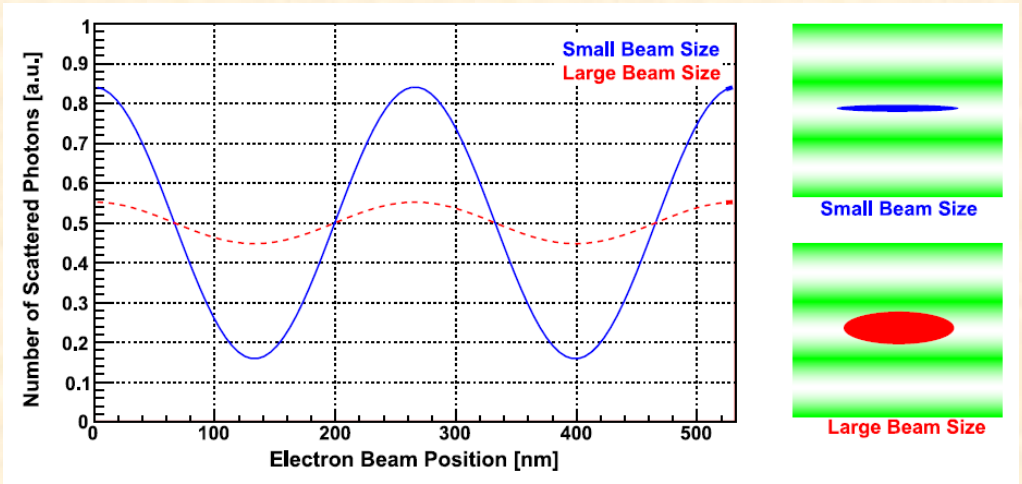


Modulation depth

$$M \equiv \left| \frac{N_+ - N_-}{N_+ + N_-} \right| = \frac{\text{Amplitude}}{\text{Average}}$$

N_+ : Measured Maximum

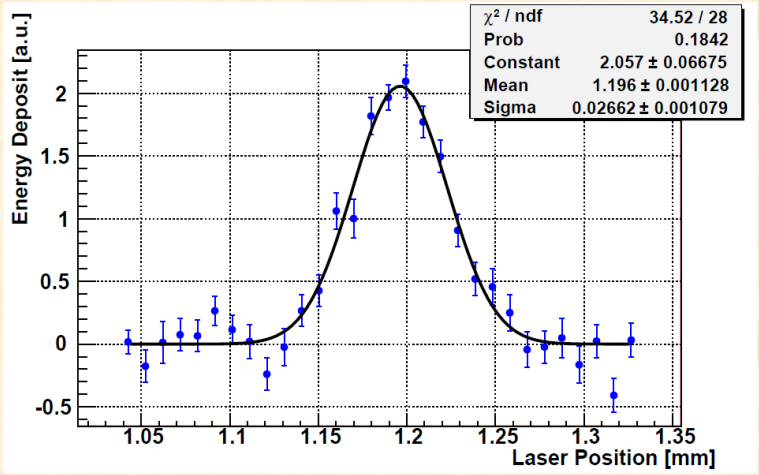
N_- : Measured Minimum



Result by End of May

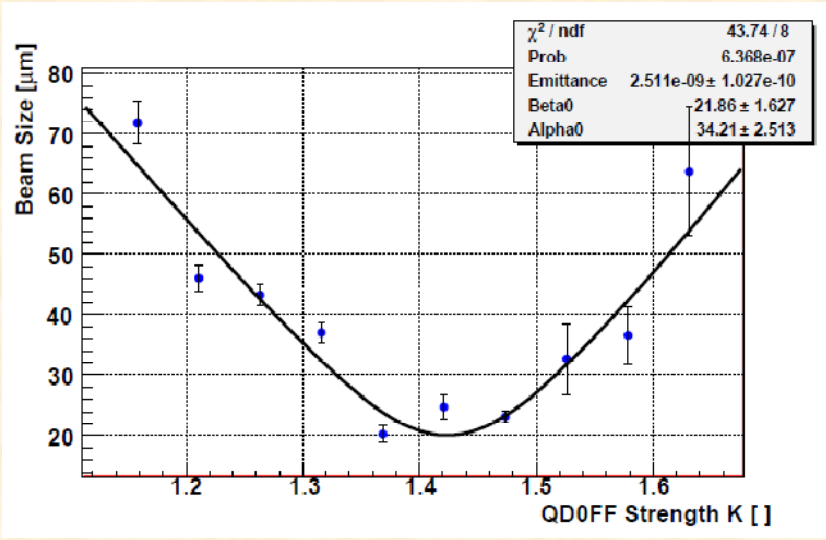
- Horizontal beam size measurement by laserwire
  - laser size at the IP : σ_L=10-15 um
- Q-scan at the IP was performed by laserwire mode

Horizontal beam size measurement



Example: σ = 26.6 um

Q-scan of horizontal beam size

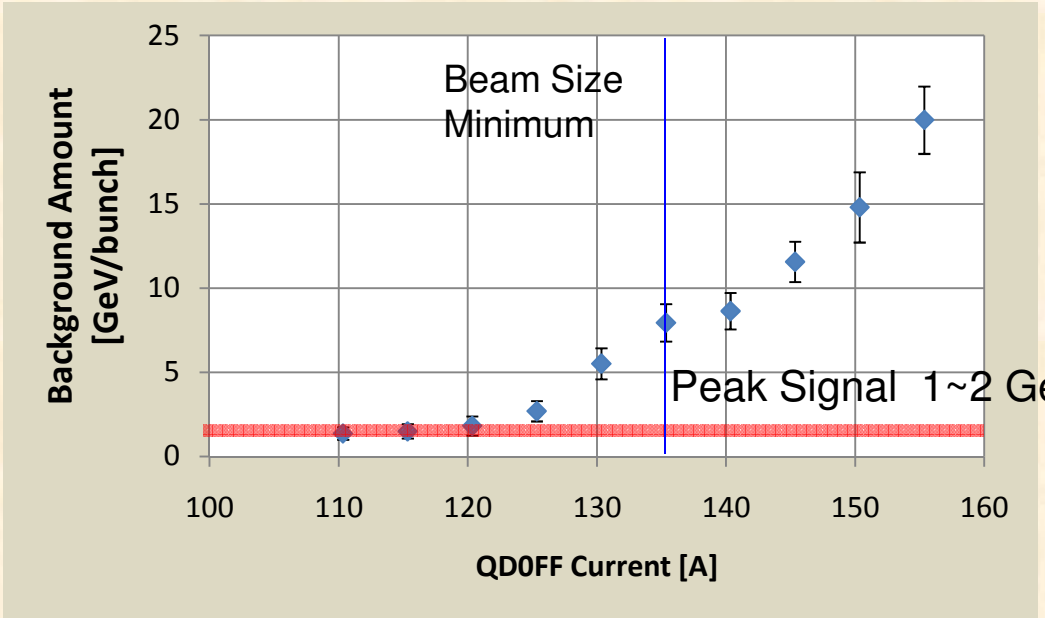


emittance from fitting ε_x = 2.5 nm (σ_L=10 um)

ε_x = 2.0 nm (σ_L=15 um)

Signal Resolution

- S/N during the horizontal beam size measurement (after the beam tuning)
  - at the beam size minimum S/N ~ 0.3
  - Signal significance (Signal / Background RMS) : 2
  - with the multi-layered gamma ray detector, signal resolution : 15 %



Background change during the horizontal beam size Q-scan

- When the strength of the final focusing magnets is changed, the background photon amount changes.
- Beam optics
  - σ_x ~ 10 μm
  - σ_y < 3 μm

Upgrade during Summer Shutdown

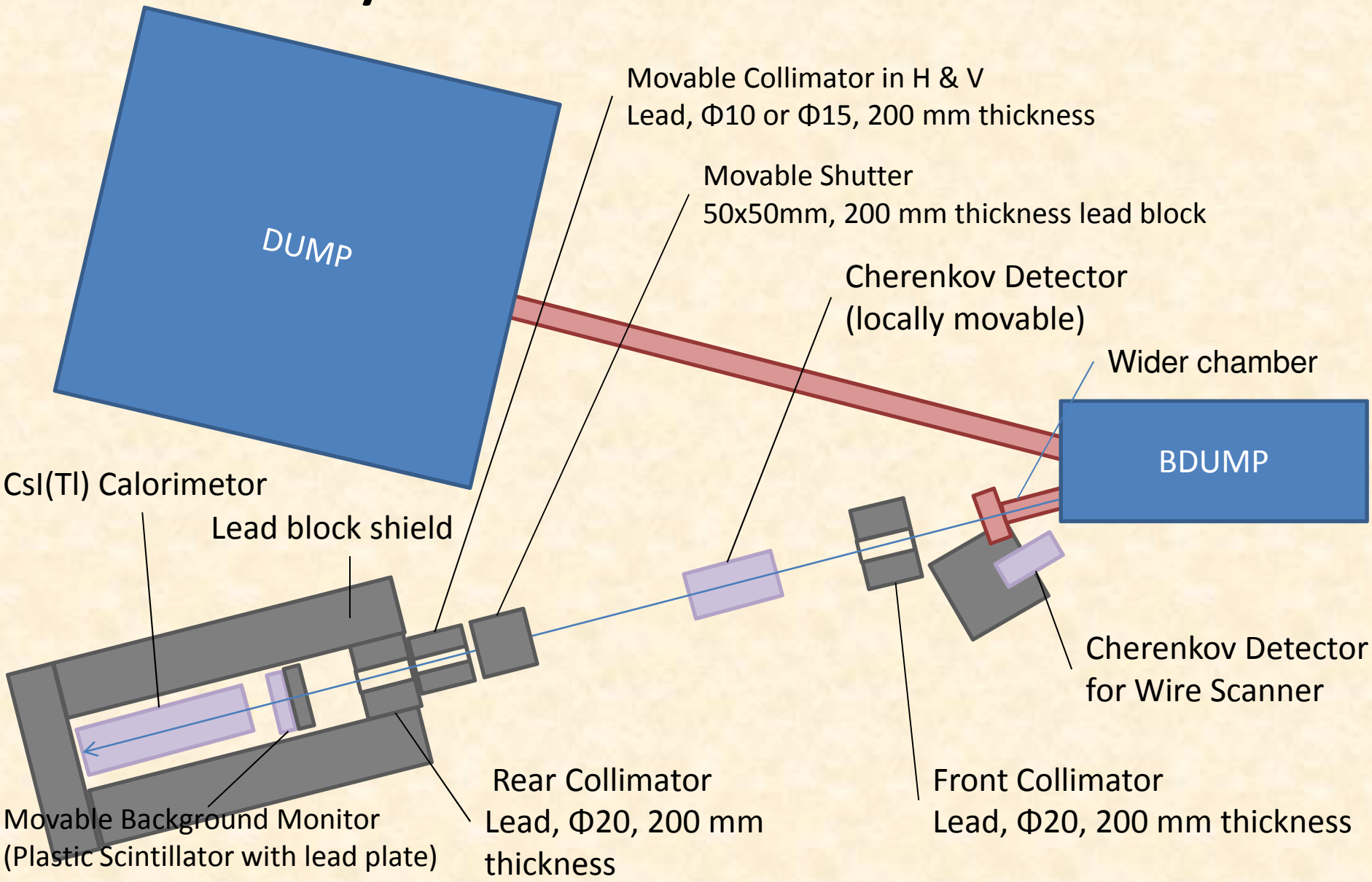
- Improve signal resolution
  - Raise the laser power
  - Add collimator
- Install the laser-beam adjustment device
- Speed up of DAQ
  - Prepare the module for 3Hz repetition rate
    (Δf Ramp for dispersion correction)

Laser Upgrade

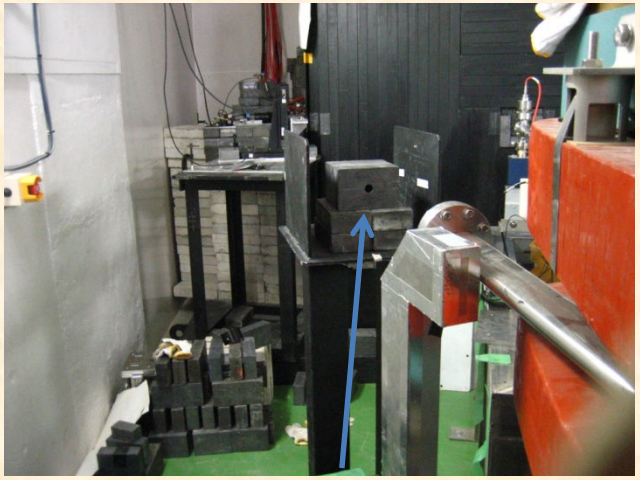
- To increase the Compton scattered photons from the laser-beam collision, replace with the stronger laser
- Laser specifications
  - Q-Switch Nd:YAG laser
  - wavelength： 532 nm （ 2nd harmonics ）
  - pulse energy： 400 mJ @ 532 nm (GCR-3, SpectraPhysics)
    → 1500 mJ @ 532 nm (PRO-350, SpectraPhysics)
  - timing jitter： < 1.0 ns
  - pulse width： 8 ns @ 532 nm
  - linewidth： < 0.004 cm^{-1} @ 532 nm

new laser
(PRO-350 Spectra-Physics)

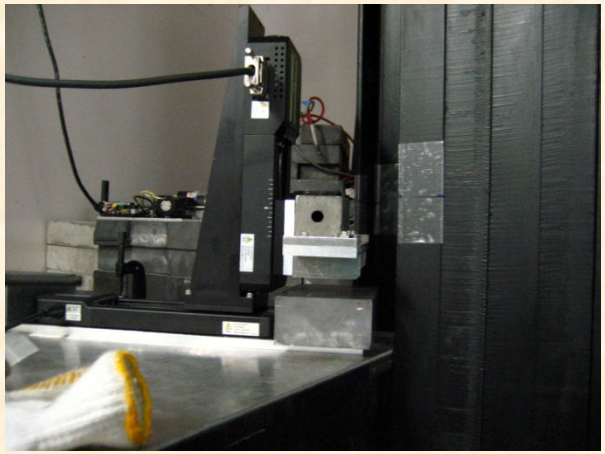
Layout around Detector



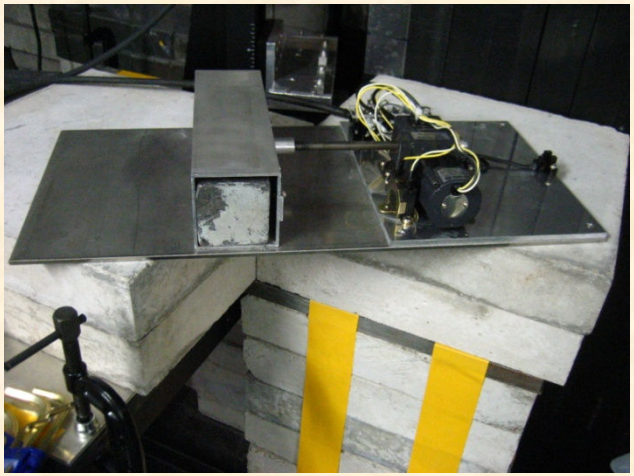
Newly Installed Devices



Front Collimator (ϕ20)



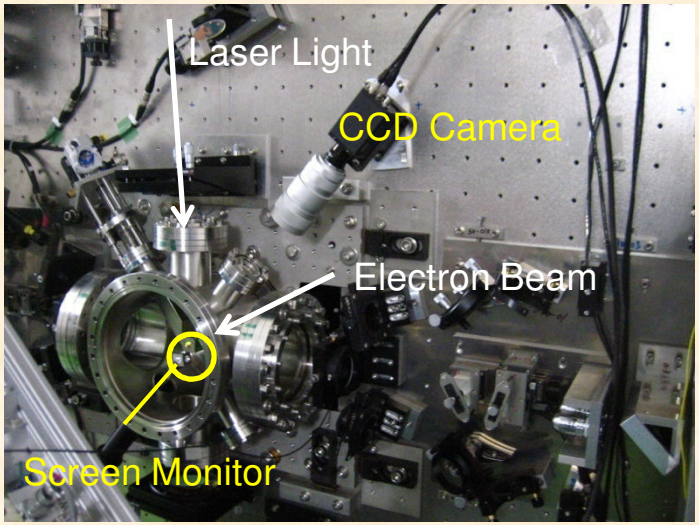
Collimator Scanner (ϕ10 or ϕ16)



Gamma ray shutter (50x50x200 mm lead block)

Laser Light Position Adjustment

- To adjust the laser position to the electron beam, screen monitor (using almina fluorescent material) is used.
- Since the previous screen monitor at the IP is temporal, reconstruction was needed to use the all the crossing mode.



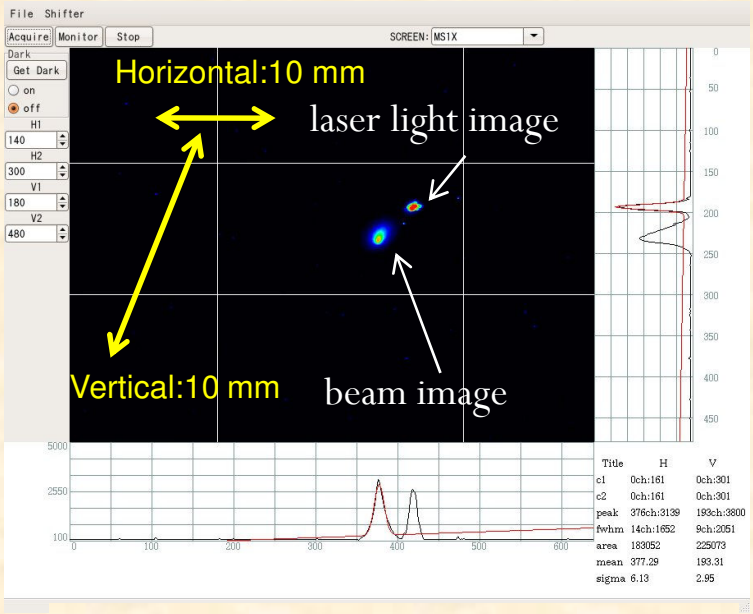
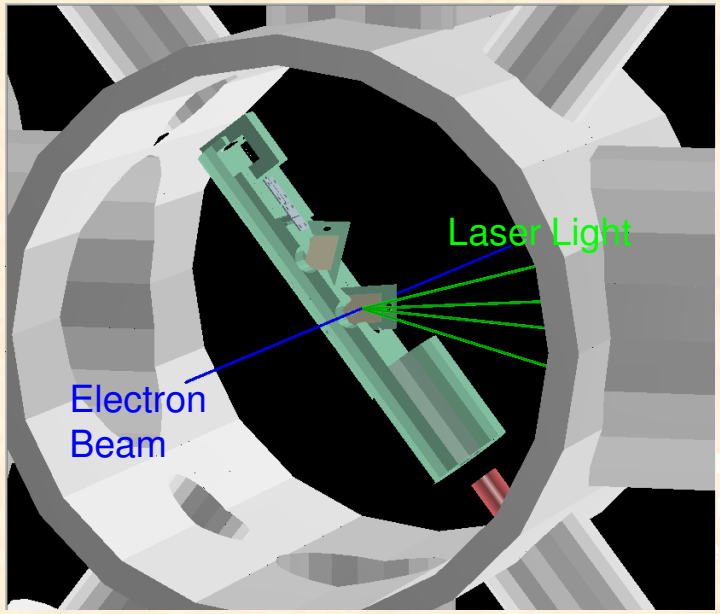


Image of screen monitor

Reconstruction of Screen Monitor

- Prepare two almina plates
  - changes according to the laser paths
- 10 um W wire is attached on the tips of the screen monitor holder
  - can measure bigger than 2-3 um vertical beam size at the IP



CAD Design

Screen Holder

Summary

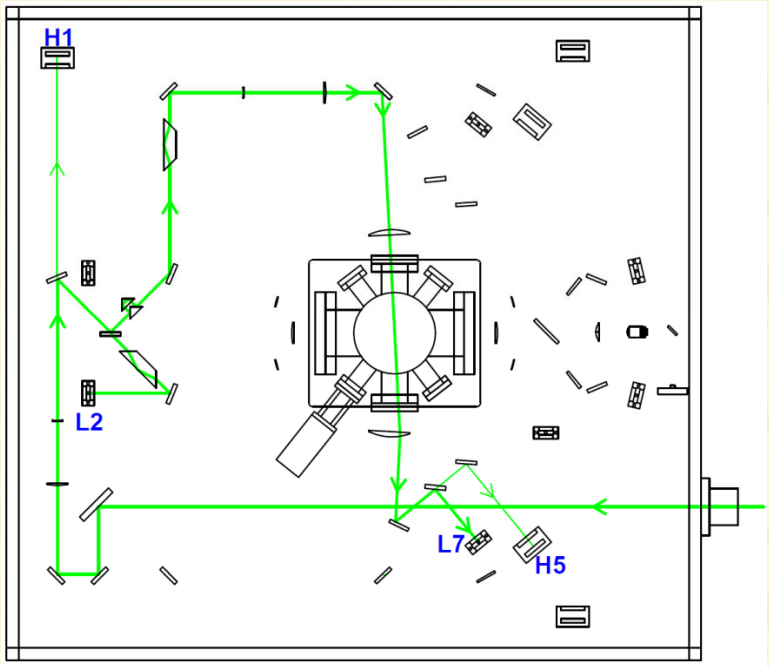
- Horizontal beam size measurement using laserwire mode have been done by the end of May.
- During the summer shutdown, upgrade for the improvement of the signal resolution and the alignment method of the interferometer mode have been continued.
- Hardware upgrade has been almost finished.

Backup

Horizontal Beam Size Measurement

- User laserwire method to measure horizontal beam size
  - horizontal beam size at the ATF2 interaction point

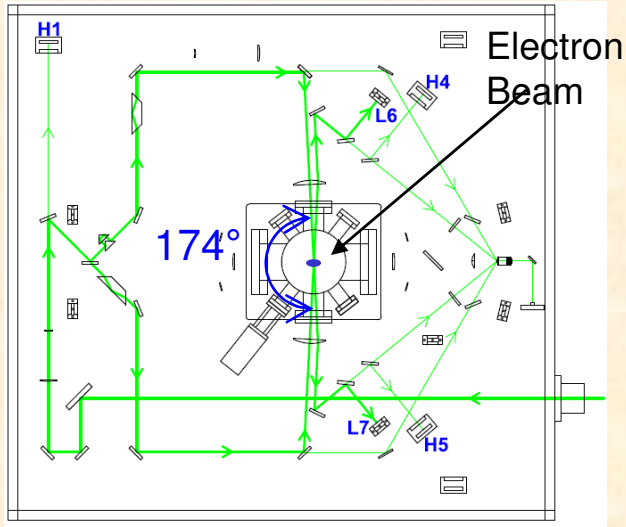
    $\sigma_x^* \geq 2.8\ \mu m$
- Laser width at the IP is estimated to be around 10 um

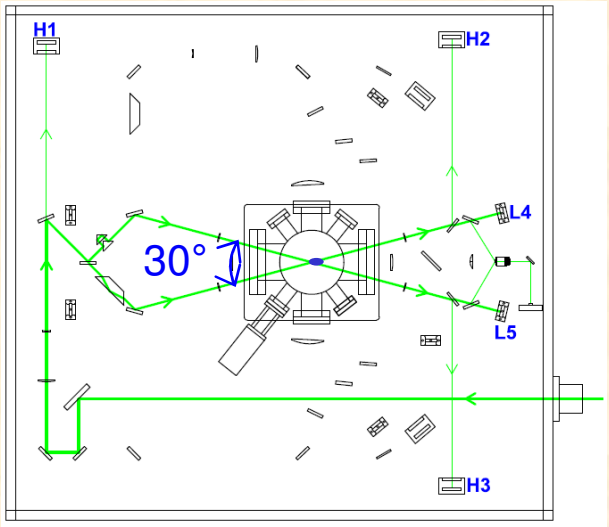


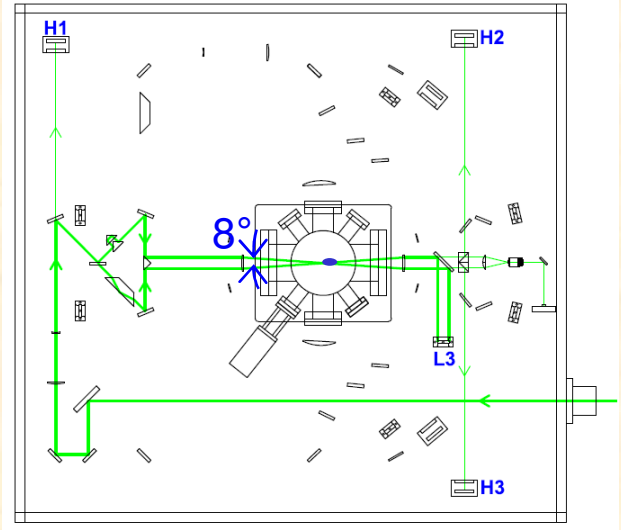
Laser path

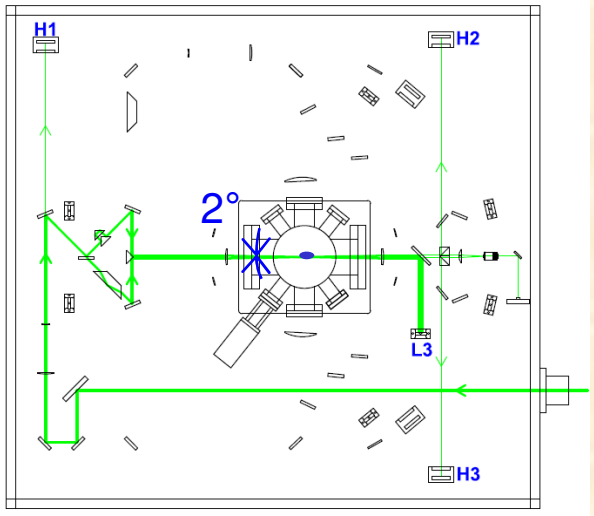
Interferometer Mode

- With only one crossing angle, measurable range is small (7 % - 40 % of laser fringe pitch)
- By switching the crossing angle, measurable beam size range is widen.

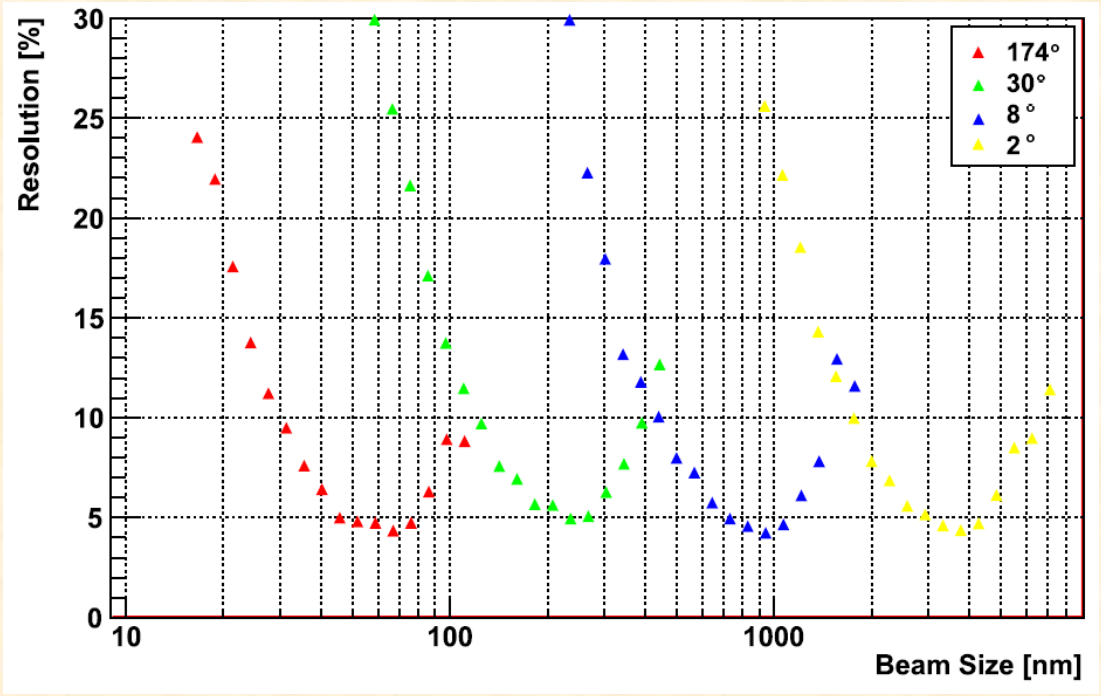








Expected Beam Size Resolution



Resolution of simulated beam size measurement

Parameters used in the simulation

- RMS of background photon amount: 10 % of signal photons
- RMS of electron beam position: 30 % of beam size
- Stability of laser fringe phase: 400 mrad
- Stability of laser power: 6.8 %
- One measurement time: 1 minute

Laser Transport from EXT LW

Laser Transport Line
(light brown plastic pipe)

Optical Table for Laser Transport
and End of Transport Pipe